IS 398-5 (1992): Aluminium conductors for overhead transmission purposes, Part 5: Aluminium conductors - galvanized steel reinforced for extra high voltage (400 kV and above)_ [ETD 37: Conductors and Accessories for Overhead Lines]

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भारतीय मानक

शिरोपरि प्रेषण उद्देश्यों के लिए ऐल्युमिनियम चालक — विशिष्टि

भाग 5 अतिरिक्त उच्च वोल्टता (400 कि वो और अधिक) के लिए जस्तीकृत-इस्पात-प्रबलित ऐल्युमिनियम के चालक

(पहला पुनरीक्षण)

Indian Standard

ALUMINIUM CONDUCTOR FOR OVERHEAD TRANSMISSION PURPOSES — SPECIFICATION

PART 5 ALUMINIUM CONDUCTORS — GALVANIZED STEEL — REINFORCED FOR EXTRA HIGH VOLTAGE (400 kV AND ABOVE)

(First Revision)

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BUREAU OF INDIAN STANDARDS
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Price Group 4

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Conductors and Accessories for Overhead Lines Sectional Committee had been approved by the Electrotechnical Division Council.

This standard has been prepared to cover the requirements of ACSR conductors for use on extra high voltage lines (400 kV and above). At such high voltages corona and radio interference attain great importance and special attention has to be paid to the finish of the conductor. Tests to ascertain conformity in this regard have also been stipulated in the standard.

This standard (Part 5) was first published in 1982. At that time the development of EHV network was envisaged at 400 kV ac only. For this system after detailed techno-economic studies by CEA, 54/3. 53 mm Al+ 7/3·53 mm steel conductor in the form of horizontal twin conductor bundle with a subconductor spacing of 450 mm was identified as the most suitable conductor. However, with the expansion of 400 kV network and with the development of ± 500 kv dc and 800 kV ac systems, use of additional types of ACSR conductors is envisaged in the country. This revision, therefore, covers three types of conductors instead of only one covered in the earlier version of the standard. It is, however, not intended to restrict the standard to the parameters of these conductors only and requirements for other conductors for EHV purpose will be added later as and when the need arises.

In the standard value adopted for resistivity of EC grade aluminium is 0·0282 64 ohm. mm^2/m at 20°C which is the value adopted in the IEC Standard also.

This part deals with aluminium conductors galvanized steel reinforced for high voltages (400 kV and above) and it forms Part 5 of the series. The other parts in the series are given below:

Part 1 : Aluminium stranded conductors

Part 2 : Aluminium conductors galvanized steel reinforced

Part 3 : Aluminium conductors, aluminium steel reinforced

Part 4 : Aluminium alloy stranded conductor

IS 398 (Part 2) : 1976 to which reference has been made in this standard is a necessary adjunct to this standard. Should, however, any deviation exist between IS 398 (Part 2) 1976 and those of this standard, the provision of the latter shall apply.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical valves (*revised*).' The number of significant places retained in the rounded off value should be the same that of the specified value in this standard.

AMENDMENT NO. 1 SEPTEMBER 2000
TO
IS 398 (PART 5) : 1992 ALUMINIUM CONDUCTOR FOR OVERHEAD TRANSMISSION PURPOSES — SPECIFICATION

PART 5 ALUMINIUM CONDUCTORS — GALVANIZED STEEL — REINFORCED FOR EXTRA HIGH VOLTAGE (400 kV AND ABOVE)

(First Revision)

(*Page* 3, *clause* **10.5**) — Add the following new clause:

'**10.6** For the purpose of calculation of breaking load and resistance, stranding constants given in Table 5 are to be used.'

Table 5 Stranding Constant

(*Clause* 10.6)

No. of Wires in Conductor		Stranding Constant		
		Mass		Electrical Resistance
Aluminium	Steel	Aluminium	Steel	
(1)	(2)	(3)	(4)	(5)
42	7	43.6	7.032	0.025 15
54	7	55.458	7.035	0.026 38

(*Page* 4, *Table* 3, *col* 3) — Substitute '7/2.30' *for* '7/2.13'.

(ETD 37)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 2 DECEMBER 2005
TO
IS 398 (PART 5) : 1992 ALUMINIUM CONDUCTOR FOR OVERHEAD TRANSMISSION PURPOSES — SPECIFICATION

PART 5 ALUMINIUM CONDUCTORS — GALVANIZED STEEL — REINFORCED FOR EXTRA HIGH VOLTAGE (400 kV AND ABOVE)

(First Revision)

[*Page* 3, *clause* 10.6, *Table* 5 (*see also Amendment No.* 1)] — Substitute the following for the existing clause:

10.6 For the purpose of calculation of mass and resistance, stranding constants given in Table 5 are to be used.

Table 5 Stranding Constant
(*Clause* 10.6)

No. of Wires in Conductor		Stranding Constant		
		Mass		Electrical Resistance
Aluminium	Steel	Aluminium	Steel	
(1)	(2)	(3)	(4)	(5)
42	7	43.053	7.045	0.024 406
54	7	55.43	7.045	0.019 009

(ET 37)

Reprography Unit, BIS, New Delhi, India

Indian Standard

ALUMINIUM CONDUCTOR FOR OVERHEAD TRANSMISSION PURPOSES — SPECIFICATION

PART 5 ALUMINIUM CONDUCTORS-GALVANIZED STEEL-REINFORCED FOR EXTRA HIGH VOLTAGE (400 kV AND ABOVE)

(First Revision)

1 SCOPE

This standard (Part 5) covers the requirements and tests for aluminium conductors, galvanized steel-reinforced used for extra high voltage overhead power lines (400 kV and above).

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

For the purpose of this standard, the following definitions in addition to those given in IS 398 (Part 2) : 1976 shall apply.

3.1 Type Tests

Tests intended to prove that the quality and design of a given type of article are in accordance with the specifications.

3.2 Acceptance Tests

Tests carried out on samples drawn from a lot for the purpose of acceptance of the lot.

3.3 Routine Tests

Tests carried out by the manufacturer/supplier on all the coils to check the requirements which are likely to vary during manufacture.

3.4 Conductor Bundle

The combination of more than one conductors perphase in parallel suitably spaced from each other used in overhead transmission lines.

3.5 Subconductor

The individual conductor in a bundle defined in 3.4.

4 PHYSICAL CONSTANTS FOR HARD-DRAWN ALUMINIUM

4.1 Resistivity

The resistivity of aluminium depends upon its purity and its physical condition. For the purpose of this standard, the maximum value permitted is 0·028 264 ohm. mm^2/m at 20°C, and this value has been used for calculation of the maximum permissible value of resistance.

NOTE — It is not intended to check the resistivity from the measured values of resistance.

4.2 Density

At a temperature of 20°C, the density of hard-drawn aluminium has been taken as 2·703 kg/dm^3.

4.3 Constant-Mass Temperature Coefficient of Resistance

At a temperature of 20° C the constant-mass temperature coefficient of resistance of hard-drawn aluminium measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely, has been taken as 0·004 per degree Celsius.

4.4 Coefficient of Linear Expansion

The coefficient of linear expansion of hard-drawn aluminium at 0° C has been taken as 23.0×10^{-6} per degree Celsius. This value holds good for all practical purposes over the range of temperature from 0°C to the highest safe operating temperature.

5 PHYSICAL CONSTANTS FOR GALVANIZED STEEL WIRES

5.1 Density

At a temperature of 20°C, the density of galvanized steel wire is to be taken as 7·80 kg/dm^3.

5.2 Coefficient of Linear Expansion

In order to obtain uniformity in calculations a value of $11{\cdot}5 \times 10^{-6}$/° C may be taken as the value for the coefficient of liner expansion of galvanized steel wires used for the cores of steel-reinforced aluminium conductors.

6 MATERIAL

6.1 The conductors shall be constructed from EC grade aluminium rods suitably hard-drawn on wire drawing machine (IS 1841 : 1978 and IS 5484 : 1978 can be referred for the aluminium rod specifications). The mechanical and electrical properties of aluminium wire shall comply with the requirements given in Table 1.

6.1.1 Galvanized steel wire should be drawn from high carbon steel rods produced by either acid or basic open heart process, electric furnace process or basic oxygen process. The mechanical and electrical properties of wire shall comply with the requirements given in Table 2. The chemical composition of high carbon steel wire is given in Annex B for the purpose of guidance.

6.2 The zinc used for galvanizing shall be electrolytic high grade zinc not less than 99.95 percent purity. It shall conform to and satisfy all the requirements of IS 209 : 1979. Galvanizing may be done either by hot process or electrolytic process. When specified by the purchaser, neutral grease may be applied between the layers of wires.

NOTE — Lithium soap grease corresponding to Grade II of IS 7623 : 1985 is suitable for such application.

7 FREEDOM FROM DEFECTS

7.1 The wires shall be smooth and free from all imperfections such as spills, splits, slag inclusion, die marks, scratches, fittings, blow-holes, projections, looseness, overlapping of stands, chipping of aluminium layers, etc and all such other defects as may hamper the mechanical and electrical properties of the conductor. Special care should be taken to keep away dirt, grit, etc during stranding.

8 STANDARD SIZES

8.1 Wires

8.1.1 *Nominal Sizes*

The aluminium and galvanized steel wires for the standard conductor covered by this standard shall have diameters specified in Tables 1 and 2. The diameter of the steel wires shall be measured over the zinc coating.

8.1.2 *Tolerances on Nominal Sizes*

8.1.2.1 *Aluminium wires*

A tolerance of $\pm 0{\cdot}5$ percent shall be permitted on the nominal diameter specified in Table 1.

8.1.2.2 *Galvanized steel wire*

A tolerance of $\pm$ 2 percent shall be permitted on the normal diameter specified in Table 2.

Table 1 Aluminium Wires Used in the Construction of Aluminium Conductors, Galvanized Steel Reinforced for Extra High Voltages

(*Clauses* 6.1, 8.1.1, 8.1.2.1, 13.5.2.1 *and* 13.10)

Diameter			Cross Sectional Area of Nominal Diameter Wires	Mass	Resistance at 20°C	Breaking Load	
Nom	*Min*	*Max*			*Max*	Before Stranding	After Stranding
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mm	mm	mm	mm^2	kg/km	Ω/km	kV	kN
3·53	3·51	3·55	9·787	26·45	2·921	1·57	1·49
4·13	4·11	4·15	13·396	36·20	2·130	2·15	2·04
4·57	4·55	4·59	16·403	44·34	1·738	2·64	2·51

NOTES

1 The resistance has been calculated from the cross-sectional area based on minimum diameter and a resistivity of 0·028264 ohm. mm^2/m.

2 The resistance of individual wires shall be such that the completed stranded conductor meets the requirements of the maximum resistance specified in col 8 of Table 3.

Table 2 Steel Wires Used in the Construction of Aluminium Conductors, Galvanized Steel-Reinforced for Extra High Voltages

(*Clauses* 6.1.1, 8.1.1 *and* 8.1.2.2)

Diameter			Cross Sectional Area of Nominal Diameter Wires	Mass	Breaking Load *Min*	
Nom	*Min*	*Max*			Before Stranding	After Stranding
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm	mm	mm	mm^2	kg/km	kN	kN
3·53	3·46	3·60	9·787	76·34	12·86	12·22
2·30	2·25	2·35	4·155	32·41	5·63	5·35
2·54	2·49	2·59	5·067	39·52	6·87	6·53

NOTE — In order to maintain the circularity of the wires the tolerances allowed in 8.1.2.1 and 8.1.2.2 shall apply to both the measurements at right angles taken at the same cross-section as per 2.2 of IS 398 (Part 2) : 1976.

8.2 Aluminium Conductors, Galvanized Steel-Reinforced

8.2.1 The size and properties of ACSR conductors shall be given in Table 3.

8.2.2 The resistance of stranded conudctor shall be in accordance with Table 3. The mass (excluding the mass of grease, if applied) is given in Table 3 for information.

9 JOINTS IN WIRES

9.1 Aluminium Wires

No joint shall be permitted in the aluminium wires in the outermost layer of the ACSR conductor. Joints in the individual aluminium wires in the layers are permitted in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 m apart in the complete stranded conductor. Such joints shall be made by the cold pressure butt-welding. They are not required to fulfil the mechanical requirements for the unjoined wires.

NOTE — Joints are not permitted in the outermost layer of the conductor in order to ensure a smooth conductor finish and reduce radio interference levels and corona losses in the extra high voltage lines.

9.2 Galvanized Steel Wires

There shall be no joints except those in the base rod or wire before final drawing, in steel wires forming the core of the steel-reinforced aluminium conductor.

NOTE — Joints have not been permitted in the steel wires after final drawing in order to avoid reduction in the breaking strength of the conductors that may occur as a result of failure of the joints.

10 STRANDING

10.1 The wires used in the construction of a galvanized steel-inforced aluminium conductor shall, before stranding, satisfy all the relevant requirements of this standard.

10.2 The lay ratio of the different layers shall be within the limits given in Table 4

10.3 The ratio of the nominal diameter of the aluminium wires to the nominal diameter of the galvanized steel wires of ACSR conductor, shall conform to the values given in Table 4.

10.4 In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being right-handed. The wires in each layer shall be evenly and closely stranded.

10.5 In conductors having multiple layers of aluminium wires, the lay ratio of any aluminium layer shall not be greater than the lay ratio of the aluminium layer immediately beneath it.

11 LENGTHS AND VARIATIONS IN LENGTHS

11.1 Standard Length

Unless otherwise agreed to between the purchaser and the manufacturer, galvanized steel-reinforced aluminium conductors shall be supplied in the lengths from 1·2 to 1·5 km.

Table 3 Aluminium Conductors, Galvanized Steel-Reinforced for Extra High Voltages

(*Clause* 8.2.2)

Nominal Aluminium Area	Stranding and Wire Diameter		Sectional Area of Aluminium	Total Sectional Area	Approx Overall Diameter	Approx Mass	Calculated Resistance at 20°C	Approx Breaking Load
	Aluminium	Steel					*Max*	*Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
mm	mm	mm	mm	mm^2	mm	kg/km	Ω/km	kN
520	54/353	7/3·53	528·5	597·0	31·77	2 004	0·055 52	161·20
560	42/4·13	7/2·13	562·7	591·7	31·68	1 787	0·051 99	120·16
690	42/4·57	7/2·54	688·9	724·4	35·04	2 187	0·042 42	146·87

NOTES

1 Mass of the conductor mentioned in col 7 is different from the mass of the corresponding conductor in other parts of this standard due to the difference in mean lay ratio specified in this part of the standard.

2 Resistance of the conductor mentioned in col 8 is different from the values specified for the corresponding conductors in other parts of this standard due to the following factors:

a) Lower values of resistivity;
b) Difference in mean lay ratio; and
c) Difference in tolerance on the nominal diameter of aluminium wire.

Table 4 Lay Ratio of Aluminium Conductors Galvanized Steel-Reinforced

(*Clauses* 10.3 *and* 13.4)

Nominal Aluminium Area	Number of Wires		Ratio Aluminium Wires Diameter to Steel Wire Diameter	Lay Ratios for Steel Core (6 Wire Layer)		Lay Ratios for Aluminium Wire					
						Outside Layer		Layer Immediately Beneath Outside Layer		Innermost Layer of Conductor with 3 Aluminium Wire Layer	
	Aluminium	Steel		*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
520	54	7	1·00	16	18	10	12	11	13	12	14
560	42	7	1·79	16	18	10	12	11	13	12	14
690	42	7	1·79	16	24	10	14	10	16	10	16

NOTE — For the purpose of calculation, the mean lay ratio shall be taken as the airthmatic mean of the relevant minimum and maximum values given in this Table.

11.2 Random Length

Unless otherwise agreed to between the purchaser and the supplier it shall be permissible to supply not more than 5 percent of the length on any one order in random lengths; none of them shall be shorter than one half of the nominal length.

12 PACKING AND MARKING

12.1 The conductor shall be wound on non-returnable drums conforming to IS 1778 : 1980 strong enough and provided with lagging of adequate strength, constructed to protect the conductor against all damages and displacements during transit, storage and subsequent

handling and straining operations in the field. Only one conductor length shall be packed on each drum.

12.2 Each drum shall have the following information marked on it along with other essential data:

a) Contract/specification number;

b) Name and address of the consignee;

c) Indicating the source of manufacture;

d) Drum number;

e) Size of the conductor;

f) Length of the conductor;

g) Gross weight of the drum with protective lagging including conductor;

h) Weight of empty drum with protective lagging;

j) Net weight of the conductor;

k) Arrow marking for unwinding; and

m) Position of the conductor end.

12.2.1 The conductors may also be marked with the Standard Mark.

13 TESTS

13.1 Classification of Tests

13.1.1 *Type Tests*

The following shall constitute the type tests:

a) Visual examination (*see* 13.2);

b) Measurement of diameters of individual aluminium and steel wires (*see* 13.3);

c) Measurement of lay ratio of each layer (*see* 13.4);

d) Breaking load test (*see* 13.5);

e) Ductility test (*see* 13.6);

f) Wrapping test (*see* 13.7);

g) Resistance test (*see* 13.8);

h) Galvanizing test (*see* 13.9);

j) Surface condition test (*see* 13.10);

k) Corona test (*see* 13.11); and

m) Radio interference voltage test (*see* 13.12)

13.1.2 *Acceptance Tests*

The following shall constitute the acceptance tests:

a) Visual examination (*see* 13.2);

b) Measurement of diameters of individual aluminium and steel wires (*see* 13.3);

c) Measurement of lay ratio (*see* 13.4);

d) Breaking load test on individual wires (*see* 13.5.2);

e) Ductility test (*see* 13.6);

f) Wrapping test (*see* 13.7);

g) Resistance test (*see* 13.8); and

h) Galvanizing test (*see* 13.9).

13.1.3 *Routine Tests*

The routine tests shall be same as acceptance tests and shall be carried out on each coil.

13.1.4 *Selections of Test Samples for Type Tests*

For the purpose of type tests samples shall be taken from a continuous length of conductor and subjected to all the tests specified in 13.1.1.

13.1.5 *Selection of Test Samples for Acceptance Tests*

13.1.5.1 For the purpose of acceptance tests samples of individual wires shall normally be taken by the manufacturer before stranding, from the outer ends of not less than 10 percent of wire coils and subjected to the tests specified in 13.1.2

13.1.5.2 Alternately, if desired by the purchaser at the time of placing an order that the tests be made in the presence of this representative, samples shall than be obtained by cutting 1·2 metres from the outer end of the finished conductor from not more than 10 percent of the finished reels or drums. If there is more than one length on any reel or drum, the sample shall be taken from the outer length.

13.1.5.3 Coils offered for inspection shall be divided into equal lots, the number of lots being equal to the number of samples to be selected a fraction of a lot being counted as a complete lot. One sample coil shall be selected at random from each lot.

13.2 Visual Examination

The conductor shall be examined visually for good workmanship and general surface finish of the conductor.

13.3 Measurement of Diameters of Individual Aluminium Steel wires

The diameter of individual aluminium and steel wire shall be checked as per the requirements specified in **8.1**.

13.4 Measurement of Lay Ratio

The lay ratios of each layer of the conductor shall be measured and checked as per the requirements specified in Table 4.

13.5 Breaking Load Test

13.5.1 *Breaking Load Test on Complete Conductor*

This test shall be carried out for the purpose of type tests only. A sample of complete conductor having a minimum length of 5 metres with compression type dead-end clamps compressed at both ends so as to permit the sample to take its normal straight line shape, shall be fixed to a suitable tensile testing machine.

13.5.1.1 An axial load shall be applied gradually and held for about 10 seconds at a load of 5000 kg. less than the specified breaking load. The load shall then be raised in steps of 500 kg. and held for about 10 seconds at each step until fracture occurs. The fracture shall not be below the breaking load specified in Table 3.

13.5.2 *Breaking Load Test on Individual Wires*

For the purpose of acceptance tests this test shall be made on both aluminium and galvanized steel wires.

13.5.2.1 The breaking load of one specimen out from each of the sample taken under **13.5.1** and **13.1.5.2** shall be determined by means of of a suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaw of the testing machine shall be not less than 25 mm/min and not greater than 100 mm/min.

The ultimate breaking load of the specimens shall be not less than the appropriate value specified in Tables 1 and 2.

13.6 Ductility Test

For the purpose of ductility test both torsion test and elongation test shall be carried out on galvanized steel wires only by the procedures given in **13.6.1** and **13.6.2**.

13.6.1 *Torsion Test*

One specimen cut from each of the samples taken under **13.1.5.1** and **13.1.5.2** shall be gripped at its ends in two vices, one of which shall be free to move longitudinally during the test. A small tensile load not exceeding 2 percent of the breaking load of the wire, shall be applied to the sample during testing. The specimen shall be twisted by causing one of the vices to revolve until fracture occurs and the number of twists shall be indicated by a counter or other suitable device. The rate of twisting shall not exceed 60 rev/min.

When tested before stranding, the number of complete twists before fracture occurs shall be not less than 18 on a length equal to 100 times the diameter of the wire. The primary fracture shall show a smooth surface at right angles to the axis of the wire. Any secondary fracture shall be ignored.

When tested after stranding, the number of complete twists before fracture occurs shall be not less than 16 on a length equal to 100 times the diameter of the wire. The fracture shall show a smooth surface at right angles to the axis of the wire.

13.6.2 *Elongation Test*

The elongation of one specimen out from each of the samples taken under **13.1.5.1** or **13.1.5.2** shall be determined. The specimen shall be straightened by hand and an original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied as described in **12.5.2.1** and the elongation shall be measured after the fractured ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm of either mark and the required elongation is not obtained, the test shall be disregarded and another test made. When tested before stranding the elongation shall be not less than 4 percent. When tested after stranding, the elongation shall be not less than 3·5 percent.

13.7 Wrapping Test

This test shall be made on both aluminium and galvanized steel wires.

13.7.1 *Aluminium Wires*

One specimen cut from each of the samples of aluminium wire taken under **13.1.5.1** or **13.1.5.2** shall be wrapped round a wire of its own diameter to form a close helix of 8 turns. Six turns shall then be unwrapped and again closely wrapped in the same direction as before. The wire shall not break or show any crack.

NOTE – Slight surface cracks shall not constitute cause for rejection.

13.7.2 *Galvanized Steel Wires*

One specimen cut from each of the samples of galvanized steel wire taken under **13.1.5.1** or **13.1.5.2** shall be wrapped round a mandral of diameter equal to 4 times the wire diameter to form a close helix of 8 turns. Six turns shall then be unwrapped and again closely wrapped in the same direction as before. The wire shall not break.

13.8 Resistance Test

This test shall be made on aluminium wires only. The electrical resistance of one specimen of aluminium wire cut from each of the samples taken under **13.1.5.1** or **13.1.5.2** shall be measured at ambient temperature. The measured resistance shall be corrected to the value at 20° C by means of the formula:

$$R_{20} = R_T \frac{1}{1 + \alpha (T - 20)}$$

where

R_{20} = resistance corrected at 20°C;

R_T = resistance measured at T°C;

α = constant-mass temperature coefficient of resistance 0·004;

T = ambient temperature during measurement.

The resistance corrected at 20°C shall be not more than the maximum value specified in Table 1.

13.9 Galvanizing Test

This test shall be made on galvanized steel wires only.

13.9.1 This test shall be made on one specimen cut from each of the samples of galvanized steel wires taken under **13.1.5.1** or **13.1.5.2.**

13.9.2 The uniformity of galvanizing and the weight of coating shall be in accordance with IS 4826 : 1979.

13.10 Surface Condition Test

A sample of the finished conductor for use in 400 kV system and above having a minimum recommended length of 5 metres with compression type dead end clamps compressed on both ends in such manner as to permit the conductor to take its normal straight line shape, shall be subjected to a tension of 50 percent of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place or disturb the longitudinal smoothness of the conductor. The measured diameter at any place shall be not less than the sum of the minimum specified diameters of the individual aluminium and steel strands as given in Tables 1 and 2.

13.11 Corona Test

For 400 kV

Two samples of conductor of 5 m length shall be strung with a spacing of 450 mm between them, shall be subject to 50 Hz phase to earth voltage. The stringing height of the bundle for the purpose of this test shall be such that the minimum clearance to ground is not more than 8·84 m. The corona control rings shall be so selected that they shield the insulators strings and hardware fittings only and do not provide shielding for the conductor bundle.

For ± 500 kV DC

Quadbundle conductors of maximum 5 m length shall be strung with a spacing of 457 mm between them, sample shall be subjected to dc voltage. The stringing height of the conductors for the purpose of this test shall be such that minimum clearance from ground is not more than 7 m (surface gradient 22 kV/cm) under dry condition. The corona control rings shall be so selected that they shield insulator strings and hardware fittings only and do not provide shielding for the conductor bundles.

For 800 kV

Quadbundle conductors of minimum 5 m shall be strung with a spacing of 457 mm between them, shall be subjected to 50 Hz voltage. The stringing height of conductor for the purpose of this test shall be such that the minimum clearance from ground is not more than 12·5 m. The corona control rings shall be so selected that they shield the insulator strings and hardware fittings only and do not provide shielding for the conductor bundles.

13.11.1 The specimen shall have a corona extinction voltage with or without corona rings of not less than the following values:

Line Voltage	*Corona Extinction Voltage* (*rms*)	*No. of Sub-Conductor in Bundle*	*Bundle Spacing*	*Height Above Ground*
400 kV ac	320 kV(rms)	2/4	45 cm	8·8 m
±500 kV dc	550 kV (line to ground) (surface gradient 22 kV/cm)	4	45·7 cm	9·7 m
800 kVac	610 kV (rms)	4	45·7 cm	12·5 m

13.11.1.1 There shall be no evidence of corona at any point of the sample. The corresponding corona inception voltage shall also be measured.

13.12 Radio Interference Voltage Test

Under the conditions specified in the corona test, the conductor shall be subjected to the following voltages (line to ground) under dry condition:

System Voltage	*RIV Test Voltage*	*Radio Interference Values Across 300 Ω Resistor at 1 MHz*
400 kV ac	305 kV (rms)	*Max* 1 000 μV
±500 kV dc	550 kV (surface gradient 22 kV/cm)	*Max* 1 000 μV
800 kV ac	510 kV	*Max* 500 μV

The test shall be carried out as per the procedure given in IS 8263 : 1976. The conductor shall have a radio interference levels below 1 000 micro volts at 1·0 MHz.

NOTE – During the test corona control rings shall be used at both ends of the conductor. The distance between the two corona control rings shall not be less than 5 metres and the tip of the rings shall not project beyond 75 mm from the crimped position of the conductor.

14 REJECTION AND RETESTS

14.1 Should any one of the test pieces first selected fail to pass the tests, three further samples from the same batch shall be selected, one of which shall be from the length from which the original test sample was taken unless that length has been withdrawn by the supplier.

14.2 Should all the three test pieces from these additional samples satisfy the requirements of the test, the batch represented by these samples shall be deemed to comply with the standard. Should the test pieces from any of the three additional samples fail, the batch represented shall be deemed not to comply with the standard.

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
209 : 1979	Zinc (*third revision*)	4826 : 1979	Hot-dipped galvanized coatings on round steel wires (*first revision*)
398 (Part 2) : 1976	Aluminium conductors for overhead transmission purposes : Part 2 Aluminium conductors galvanized steel reinforced (*second revision*)	5484 : 1978	Autoclaved cellular concrete blocks
1841 : 1978	EC grade aluminium rod produced by rolling (*second revision*)	7623 : 1985	Lithium base grease for industrial purposes (*first revision*)

ANNEX B

(*Clause* 6.1.1)

CHEMICAL COMPOSITION OF HIGH CARBON STEEL

B-1 The chemical composition of high carbon steel used in the manufacture of steel wire of ACSR conductor is given below for guidance:

Element	*Percentage Composition*
Carbon	0·50 to 0·85
Manganese	0·50 to 1·10
Phosphorus	*Max* 0·035
Sulphur	*Max* 0·045
Silicon	0·10 to 0·35

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